

## Distribution of *Spermophilus citellus* in the Komárom-Esztergom County, Hungary, in 1950–2019 (Rodentia: Sciuridae)

Rozšíření sysla obecného (*Spermophilus citellus*) v Komárňansko-Ostříhomské župě, Maďarsko, v letech 1950–2019 (Rodentia: Sciuridae)

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**Abstract.** The study describes changes in the Hungarian population of the European ground squirrel (*Spermophilus citellus*) that occurred between 1950 and 2019. Data before 1990 were collected from local communities who were familiar with this mammal (an example of citizen science). The comparison was based on the area occupied by the animals. The studied region was in the Komárom-Esztergom County, north-western Hungary, where the species was widespread in the middle of the 20th century. It was common in the lowlands, low hilly country and even in suitable habitats in uplands. By 1990 the population had drastically declined, to about 1.5% of the previous levels, and today 99.7% of the population has disappeared with only small, vulnerable populations surviving.

**Key words.** Long term study, grasslands, meadow management, grazing, population rapid decline.

### INTRODUCTION

The European ground squirrel, *Spermophilus citellus* (Linnaeus, 1766), is a rodent found in Central and south-eastern Europe. Its range is disjunctive, having two parts: the ‘Pannonian population’ in the south-eastern Czech Republic, in Slovakia, north-eastern Austria, Hungary, western Romania, northern Serbia, and in southern Poland, where it was reintroduced; and the ‘Balkan population’ in Ukraine, Moldova, eastern and southern Romania, south-eastern Serbia, eastern North Macedonia, Bulgaria, northern Greece, and Turkish Thrace (WILSON et al. 2016). It was once common and widespread in Hungary and considered a serious agricultural pest, with large-scale pest-control measures implemented. It was also trapped and consumed by some local communities. Due to its serious decline the species is currently categorized as strictly protected by law. In many areas, populations have either disappeared or only survive in small, isolated, and vulnerable colonies (VÁCZI et al. 2007).

The decline of the species in Hungary over the last fifty years is obvious, however, no specific data on the extent of this decline have been collected. Scientists only began to study this species in detail in the 1980s and at first most observations were only local. A systematic survey of the Hungarian population began in the early 1990s and continued since the 2000s using an agreed methodology. Over the past three decades a wealth of data on the distribution, abundance, and

population changes in this rodent have been collected (VÁCZI 2019). Although little information exists on its previous distribution and status, today the species is rare and endangered.

In order to establish the reasons behind the decline of the species, a reliable methodology for studying the species over a prolonged period and over a wide area was sought.

## MATERIAL AND METHODS

The European ground squirrel was once a well-known animal in the Hungarian countryside. It was often found in the habitats such as continually used pastures, fields, and orchards, in and around human settlements. Thus, people were familiar with the species and in many areas even hunted it for food. This paper draws on the fact that the ground squirrel is still very much in the minds of rural people (thus a form of ‘citizen science’ was employed). Because the sizes of earlier populations were difficult to determine this survey was based upon the extent of the area where the species occurred.

Before beginning this study, I elaborated and tested a data collection and validation protocol which subsequently proved to be effective. The study area comprised the Komárom-Esztergom County (north-western Hungary), a region where the species occurred in both lowlands and uplands, i.e. all the most important habitat types where the ground squirrels could ever live. I visited all the settlements and farms in the county in 2010–2012 and conducted interviews with local elderly people. This data collection took approximately 35 field days. It was undertaken almost at the last minute because over time collecting data from the 1950s became more difficult.

Outline of the data collection: (1) recognition (can the interviewee describe the animal and its behaviour); (2) knowledge of where the animals are/were present in their area (as far back as the 1950s); (3) exact location of the animals; (4) type of habitat; (5) how many animals there were (only a few, not so many, many, abundant etc.); (6) when the animals disappeared; (7) why they disappeared.

Scrutiny of the data: (1) does the interviewee know the species? (2) verification of the described habitats and their boundaries (using aerial photographs and military maps); (3) comparison of data from different interviewees.

Creation of a data record: (1) name of the area; (2) nearest settlement; (3) period when the ground squirrel was present; (4) likely cause of disappearance; (5) habitat type; (6) altitude; (7) size of the inhabited areas (in hectares) in different periods of 1950–2019; (8) comments; (9) observers/interviewees; (10) other information.

I collected the negative data too, since I wanted to know in what places which seemed suitable were no animals. I also examined the changes of the habitats and land use over the past seven decades. I checked the current condition of the habitats too. The ground squirrel used to live in the cultivated fields in the past, but sometimes only occasionally. I counted only those arable fields where the ground squirrels were resident. Even so, it was difficult to determine the exact extent of the squirrel-populated arable land. The estimated area is probably smaller than it actually was. The number of colonies is sometimes difficult to give especially in the 1950s. At that time the squirrel was common and the habitats were often interconnected. I considered a locality to be a more or less well-defined patch of habitat.

## RESULTS

### Data collection experience

Most respondents were obviously familiar with the ground squirrel. Indeed, most of the interviewees had killed the animals in the past, having regarded them as agricultural pests, and almost half had eaten ground squirrels (I was even given recipes!). Local people knew how the squirrels behaved and several hunting methods were described.

Table 1. Extent of the habitats (in hectares) occupied by the European ground squirell (*Spermophilus citellus*) in particular sections of the Komárom-Esztergom County in seven periods of 1950–2019. Underlined are the three highest values per period

Tab. 1. Rozsah biotopů (v hektarech) obývaných system obecným (*Spermophilus citellus*) v jednotlivých částech Komárňansko-Ostřihomské župy v sedmi úsecích období 1950–2019. Podržené jsou tři nevyšší hodnoty v rámci každého úseku

area / území	year / rok	1950	1970	1985	1995	2005	2012	2019
Vértes		166.9	147.0	90.0	0	0	0	0
Vértesalja		1,680.7	1,133.0	<u>459.0</u>	<u>123.0</u>	<u>90.1</u>	<u>84.2</u>	<u>18.0</u>
Bakonyalja		1,083.8	400.0	91.0	2.0	0	0	0
Kisalföld		<u>6,519.6</u>	<u>2,373.0</u>	<u>1,151.0</u>	<u>80.0</u>	<u>24.1</u>	<u>5.3</u>	1.5
Gerecse		<u>4,309.9</u>	<u>1,222.0</u>	451.0	<u>36.5</u>	<u>13.0</u>	<u>14.1</u>	<u>37.0</u>
Keleti-Gerecse		<u>3,082.9</u>	<u>1,202.0</u>	390.0	25.0	7.0	4	<u>4.0</u>
Pilis-Visegrád Mts.		1,338.5	778.0	<u>629.0</u>	2.0	0	0	0
total / úhrnem		18,182.3	7,255.0	3,261.0	268.5	134.2	107.6	60.5
% of the area / plochy 1950			39.9	17.9	1.5	0.7	0.6	0.3

#### Distribution status in the 1950s

The species was widespread in lowland areas in north-western Hungary in the 1950s. Although many of the region's grasslands had been ploughed up by the 20th century, many thousands of hectares remained until the early 1950s, especially in sandy areas. The animals lived mainly on these remaining grasslands (the largest colony was at a site of over 1,500 hectares). They were also commonly found along roadsides and railway lines and occasionally in vineyards (between the rows of vines) and on grassy patches around cellars. Some populations used arable land, usually edge habitats, but also entire fields would be occupied if they were not deeply ploughed. Stubble fields were colonized in the summer but abandoned in autumn when heavy ploughing

Table 2. Number of colonies of the European ground squirell (*Spermophilus citellus*) in particular sections of the Komárom-Esztergom County in seven periods of 1950–2019

Tab. 2. Počty kolonií sysla obecného (*Spermophilus citellus*) v jednotlivých částech Komárňansko-Ostřihomské župy v sedmi úsecích období 1950–2019

area / území	year / rok	1950	1970	1985	1995	2005	2012	2019
Vértes		5	3	1	0	0	0	0
Vértesalja		53	37	12	4	3	2	2
Bakonyalja		41	19	4	1	0	0	0
Kisalföld		184	78	35	16	8	3	1
Gerecse		153	49	24	11	3	2	2
Keleti-Gerecse		97	48	12	6	5	3	3
Pilis-Visegrád Mts.		28	6	3	1	0	0	0
total / úhrnem		561	240	91	39	19	10	8
% of the number / počtu 1950			42.8	16.2	7.0	3.4	1.8	1.4

was often carried out. Sometimes small numbers even appeared in gardens in settlements. The ground squirrel was common in the foothills of the Vértes, Gerecse, and Pilis Mountains in the 1950s. The species lived mostly in grassland habitats but was also widespread in the agricultural land in Gerecse where traditional and less intensive cultivation prevailed. For example, the land was lightly ploughed using horses and cattle, and this was often done during the hibernation period of the squirrels, so they were not unduly disturbed. In addition, there were many areas of fallow land in Gerecse. The ground squirrel colonized many hilly environments, mainly in areas with southern facing slopes, residing in grasslands, clearings and sometimes farmland. It had, however, become rare or had disappeared entirely from more truly montane habitats.

Data from 561 sites known from the 1950s were collected. The minimum area colonized by the ground squirrels at that time was 18,182 hectares, a figure which does not include a significant amount of arable land (Tables 1 and 2). A reasonable estimate of the total area of distribution is around 20,500 hectares. Most of the animals were found in the studied area in foothills.

To summarize, the European ground squirrel was a common and widespread species in the region in the 1950s. However, without doubt it caused some damage to agriculture and was thus regarded as a pest and systematically hunted. Nonetheless, its population remained stable (Fig. 1).

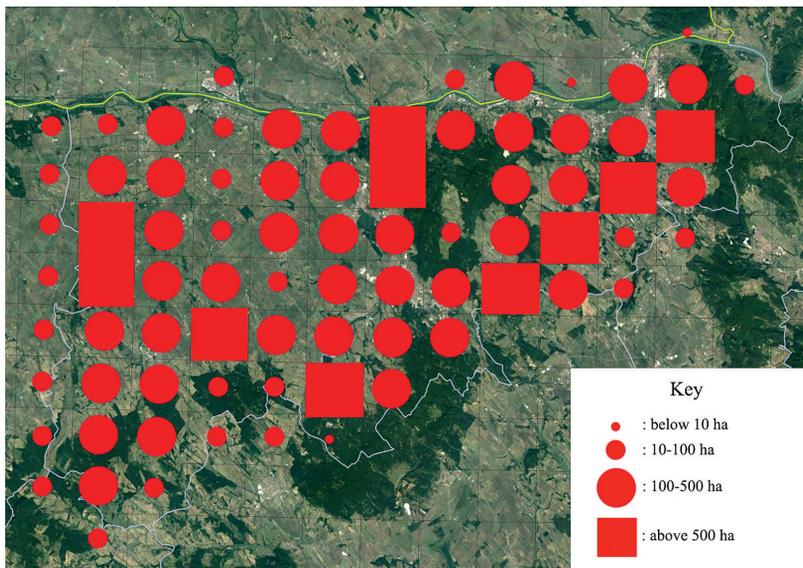


Fig. 1. Distribution of the European ground squirrel (*Spermophilus citellus*) in the Komárom-Esztergom County in the 1950s.

Obr. 1. Rozšíření sysla obecného (*Spermophilus citellus*) v Komárnansko-Ostřihomské župě v 50. letech 20. století.

Table 3. Percentage distribution of habitats occupied by the European ground squirell (*Spermophilus citellus*) in particular sections of the Komárom-Esztergom County in four periods of 1950–2019. Underlined are the three highest values per period

Tab. 3. Procentuální zastoupení biotopů obývaných system obecným (*Spermophilus citellus*) v jednotlivých částech Komárňansko-Ostříhomské župy ve čtyřech úsecích období 1950–2019. Podrženy jsou tři nevyšší hodnoty v rámci každého úseku

area / území	year / rok	1950	1985	2005	2019
Vértes		0.92	2.76	0	0
Vértetalja		9.24	<u>14.08</u>	<u>67.13</u>	<u>29.75</u>
Bakonyalja		5.96	2.79	0	0
Kisalföld		<u>35.86</u>	<u>35.30</u>	<u>17.96</u>	2.48
Gerecse		<u>23.70</u>	13.83	<u>9.69</u>	<u>61.16</u>
Keleti-Gerecse		<u>16.96</u>	11.96	5.22	<u>6.61</u>
Pilis-Visegrád Mts.		7.36	<u>19.28</u>	0	0

#### Distribution status in 1958–1989

In the late 1950s agriculture in Hungary underwent a major overhaul that focused on collectivization. Farming became widely mechanized with ploughing deeper than ever before, huge contiguous fields being created, and some grasslands afforested. All this resulted in the ground squirrels disappearing from many areas, often within a year of the changes being implemented. It is thought that almost two-thirds of the suitable ground squirrel habitat was lost. From the 1970s, farming became even more intensive with pesticides used on an industrial scale which resulted in further declines of the species. In addition, the number of grazing livestock was significantly reduced which resulted again in changes in the structure of grasslands which were negative for ground squirrels. Today, these areas are mostly covered by shrubs. Compared to the above changes, other developments such as an increase in mining, industrial complexes, and settlements, were less detrimental to these rodents.

By the mid-1980s the total area inhabited by the ground squirrel in the studied region had decreased to under 18% when compared to that of the early 1950s (Table 1). The population numbers fell most sharply in foothills: in Bakonyalja 8.4%, on the edge of the Gerecse Mountains ca. 10%, and in the eastern Gerecse 12.7% remained.

In the same period in the studied region 35% of these rodents lived in the plains (Kisalföld), meaning that the proportion of lowland habitats has remained virtually unchanged since the 1950s (36% vs. 35%; Table 3). However, in proportion, numbers across whole Gerecse, a region that had previously held more than 40% of the population, fell to around 26%: the species disappearing from over 6,500 hectares in just 30 years. This was due to both the agricultural intensification methods already mentioned as well as a shift to a more urban lifestyle (fewer livestock farmers) by rural populations. On the other hand, the proportion of the ground squirrels in the Pilis and Visegrád Mts. (19%) and the northern slopes of the Vértes Mts. (14%) gained significance as the numbers decreased there to a much lesser extent. The collapse of the Bakonyalja populations was due to the plowing and to the abandonment of grazing pastures.

## Population status in 1990–2019

Since 1990 I have documented my own observations of ground squirrels. Soon after the political changes that began in 1989, the agricultural collective system ceased to exist, but the number of grazing livestock continued to decline. Thus, many grasslands in hilly areas became overgrown and in the drier lowlands they became too tall. Obviously, these situations were unfavorable for the ground squirrels and by the end of millennium only 39 isolated and threatened populations remained (Fig. 2).

By the mid-1990s less than 7% of previously occupied ground squirrel localities in the study area remained (Table 2). The overall range of the species in the region had fallen to less than 1.5% of what it had been in the middle of the 20th century (Table 1). In addition, most colonies consisted of only a few individuals. The species had totally disappeared from the Vértes and Visegrád Mts., and only one location in the Pilis Mts. (Esztergom) and one in the Bakonyalja region (Súr) remained. A lesser decline occurred in the northern foreground of the Vértes Mts. with noteworthy colonies persisting near Kecskéd (in an airfield).

Over the next decade, the population continued to decline, with around a half disappearing and no populations remaining in the Pilis Mts. and the Bakonyalja area, respectively, as these isolated, small sized populations were no longer viable. The remaining number of the colonies was 19 with nine of these in reasonable condition (high number of individuals, adequate habitat

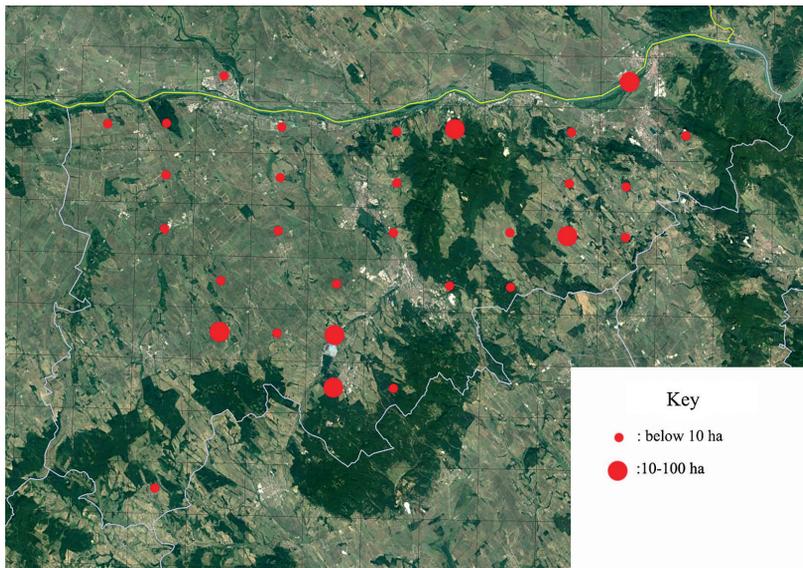


Fig. 2. Distribution of the European ground squirrel (*Spermophilus citellus*) in the Komárom-Esztergom County in 1995.

Obr. 2. Rozšíření sysla obecného (*Spermophilus citellus*) v Komárňansko-Ostříhomské župě v roce 1995.

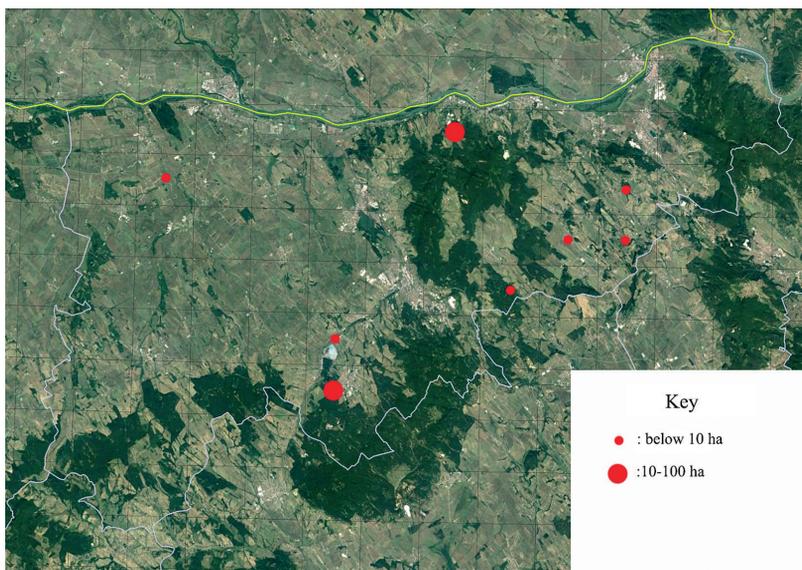


Fig. 3. Distribution of the European ground squirrel (*Spermophilus citellus*) in the Komárom-Esztergom County in 2019.

Obr. 2. Rozšíření sýsla obecného (*Spermophilus citellus*) v Komárnansko-Ostříhomské župě v roce 2019.

management) and ten critically endangered. By far the biggest colony (at least 450 animals) was at the Kecskéd airport. These figures resulted from the first ever population estimate in the region (CSONKA & RIEZING 2004).

The overall population continues to decline even today. Many populations considered stable in 2004 have disappeared since that. For example, a colony at the Esztergom airport was totally wiped out by flooding in 2010, an unusually rainy year. Elsewhere these rodents disappeared owing to the abandonment of grazing or the constant presence of predatory domestic cats. Only eight populations currently survive, however six of these are small (consisting of very few individuals) and are vulnerable. The Kecskéd airport colony, once the largest, has also undergone a dramatic decline in recent years as the spring mowing only takes place on a narrow strip of the runway. The grass is left to grow high and only mown in mid-summer which is unsuitable and too late for the ground squirrels which subsequently disappear. Now, only a few individuals remained in the narrow lane of the runway. The abandonment of traditional meadow management is a problem at other sites, for example, near Bokod where they have not been mown for several years. The population there decreased and seemed to be doomed, until a few years later the farmer began to use mowing and grazing again, and the small remaining colony began to grow once more and is now the second largest in the Komárom-Esztergom County. Currently, the only colony which seems stable and assured is at Gombáspuszta near Neszmély in the Gerecse Mts., however this is due to the conservation activities (habitat management, reintroduction scheme) carried out there.

The total area inhabited in 2019 was 60.5 ha, just 0.3% of that in the 1950s (Table 1). Furthermore, the density today is much lower than it was half a century ago and according to conservative estimates the overall population in the study area has fallen to about 0.1–0.2% of what it was seventy years ago.

### Historical perspective

Based on the data collected and knowledge of previous land use, it is possible to estimate the distribution of the species in the Komárom-Esztergom County up to the mid-20th century. From a historical perspective we can note that large areas of the county were uninhabited by people during the Ottoman era (16–17th century). Most of these areas were only forested in the foothills and mountains. Current knowledge indicates that lowlands (Kisalföld) were deforested at that time, so the ground squirrel may have been common there.

After the Ottoman era, the county was inhabited again (at the end of the 17th century and the beginning of the 18th century) and forest cover was rapidly reduced and arable land and grassland increased, particularly in foothills (RIEZING 2011). It is therefore likely that the species occupied these newly created suitable habitats.

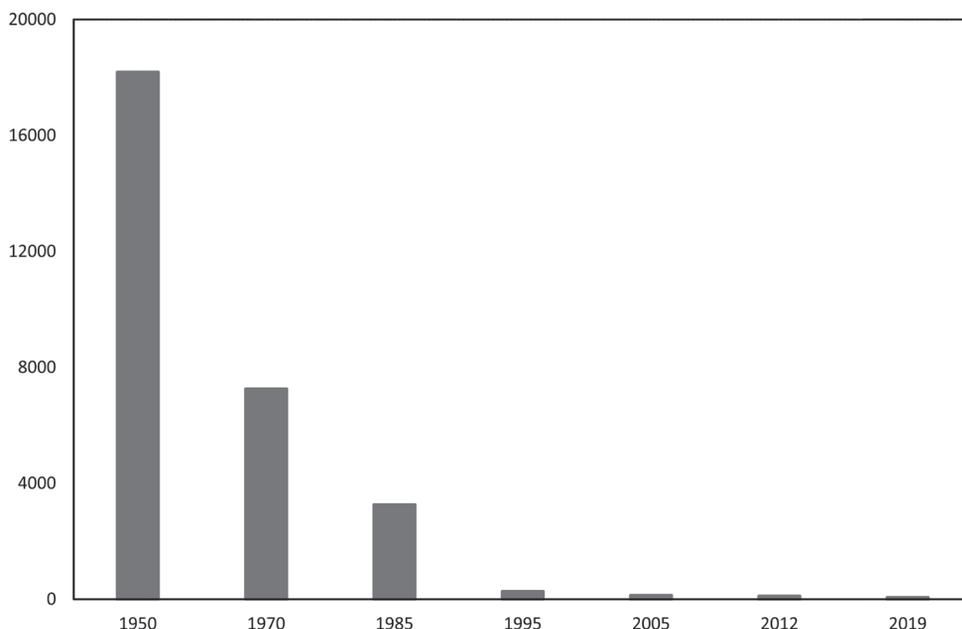


Fig. 4. Population trends of the European ground squirrel (*Spermophilus citellus*) in the Komárom-Esztergom County between 1950 and 2019. Vertical axis shows habitat size in hectares.

Obr. 4. Populační trendy sysla obecného (*Spermophilus citellus*) v Komárňansko-Ostřihomské župě v období mezi roky 1950 a 2019. Svislá osa ukazuje velikost biotopu v hektarech.

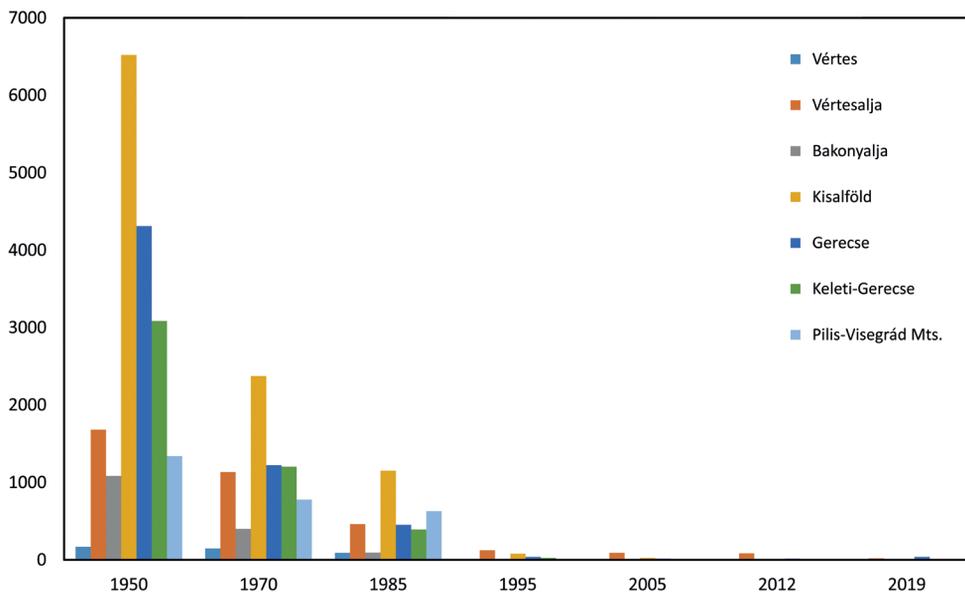


Fig. 5. Population trends of the European ground squirrel (*Spermophilus citellus*) in particular areas of the Komárom-Esztergom County between 1950 and 2019. Vertical axis shows habitat size in hectares. Lowland: Kisalföld. Foothills: Vértésalja, Bakonyalja, Keleti-Gerecse, a part of the Gerecse. Uplands: Vértés, parts of the Gerecse, Pilis-Visegrádi Mts.

Obr. 5. Populační trendy sysla obecného (*Spermophilus citellus*) v jednotlivých územích Komárňansko-Ostříhomské župy v období mezi roky 1950 a 2019. Svislá osa ukazuje velikost biotopu v hektarech. Nížina: Malá dunajská nížina (Kisalföld). Podhůří: Vertešské podhůří (Vértésalja), Bakoňské vrchy (Bakonyalja), Východní Gereče (Keleti-Gerecse), částečně Gereče. Pahorkatiny: Vertešské vrchy (Vértés), částečně Gereče, a Pilišsko-Výšehradské vrchy (Pilis-Visegrád).

The conversion of forests into arable land or grasslands can be seen in the old military maps (from 1782 when the first military mapping survey took place). These fields were cultivated using medieval methods (three-pressure farming) which meant shallow ploughing and significant areas left fallow, both of which were ideal for ground squirrels. Hence, by the end of the 19th century, the species may have been widespread in the region, including in the Vértés, Gerecse, Pilis, and Visegrád Mountains, and in Bakonyalja. The populations may also have been at their largest levels ever at that time.

At the end of the 19th century, significant changes had begun in the lowland (Kisalföld) region when the first steam traction engines were used for ploughing on large estates (RÉZ 2012). The resultant deeper ploughing led to ground squirrels disappearing from many areas, only surviving where narrow strips of grassland remained between fields. Soon after, steam engines were replaced by tractors (RÉZ 2019) and by the middle of the 20th century, ground squirrels had disappeared from many farmed lowland areas. In addition to crop production techniques, other changes occurred at that time, too. The extensive grazing of livestock was replaced by intensive farming and many pastures thus ploughed up. The level of decline in the ground

squirrel population in that period is difficult to estimate but it was probably significant and by the mid-20th century most of the remaining colonies in the Komárom-Esztergom County were in foothills and uplands.

## DISCUSSION

As mentioned above, much of the Komárom-Esztergom County was uninhabited during the Ottoman era (16–17th century). Most of these areas, but particularly in the foothills and uplands, became forested. At the end of the 17th century and the beginning of the 18th century, the region was repopulated and forest cover, chiefly in the foothills, began to fall again. These areas were converted to arable land and grazing land, both of which were presumably suitable habitats for ground squirrels. Henceforth, by the end of the 19th century, the species was probably widespread as many suitable habitats then existed in both foothills and some hilly area interiors and the ground squirrel populations at that time may well have been the largest ever. At the end of the 19th century when farming became increasingly mechanized and intensive on the lowlands, ground squirrels began to decline and by the middle of the 20th century had disappeared from many places in the plains although they were still rather common overall.

Specific county-wide datasets for the species have been available since the 1950s. The ground squirrel's habitat is known to have covered more than 18,000 hectares, with about two-thirds in foothills and hills. This rodent was common on grasslands, but also lived in some agricultural areas, vineyards, gardens, fallow land and occasionally on stubble fields. By the beginning of the 1990s it had disappeared from the 98.5% of its former haunts. The main reason for this drastic decline was the restructuring of agriculture in Hungary which included increased mechanization, intensification, habitat loss due to ploughing and afforestation, the abandonment of meadows, and use of insecticides, pesticides, and rodenticides. When my own observations commenced in the 1990s, only 39 isolated and vulnerable populations existed, and numbers continued to decline over the following three decades as these small populations were no longer viable. Some of the larger colonies disappeared entirely or declined owing to an absence of suitable habitat management or unfavorable weather conditions (high precipitation) and other negative factors such as illegal poisoning, trapping and predation by domestic cats.

Today, only eight colonies remain in the county, six of which consist of just a few individuals. The total area inhabited by ground squirrels in 2019 was 60.5 ha which is merely 0.3% of that in the 1950s. Consequently, 99.7% of its habitats have disappeared and in addition, today's density is much lower than it was half a century ago. According to careful estimates, the overall population has fallen to about 0.1–0.2% in the past seventy years. The European ground squirrel, which was once so common it was regarded by some as a serious pest, is now critically endangered in the Komárom-Esztergom County.

The decline processes presented here and the reasons behind them are believed to have developed in a similar way in the other parts of the Carpathian Basin. Nevertheless, there have been differences in these processes, such as them taking place at different times or to lesser extents. For example, on the Hungarian Great Plain, where the land is less suitable for cultivation (for example on sandy or saline areas), potential habitats disappeared more slowly than in the foothills, uplands, and more populated and industrialized areas. The rate of decline over the past two decades in the study area is similar to that recorded during the national survey (VÁCZI 2019). Overall, the decline of the European ground squirrel population could have been similarly catastrophic in the other parts of the Carpathian Basin (see JANÁK et al. 2013).

## ÖSSZEFOGLALÁS

A dolgozat a közönséges ürge állományának változását mutatja be az 1950–2019 közötti időszakban. Az 1990 előtti adatokat az állatot és adott területeket jól ismerő adatközlők szolgáltatták. A felmérés szisztematikusan, egységes módszer alapján történt, mely lehetőséget nyújtott az adatok visszaellenőrzésére is. A különböző időszakok összehasonlítása az állatok által elfoglalt terület alapján történt. A múlt század közepén a vizsgált megyében az ürge általánosan elterjedtnek tekinthető mind az alföldi, mind a hegylábi és dombvidéki régiókban, sőt a hegyvidékek alkalmas élőhelyein is megjelent. 1990-re az állomány drasztikusan, a korábbinak mintegy 1,5%-ára csökkent. Napjainkra az állomány lényegében összeomlott: 99,7%-a eltűnt! Kisebb, sérülékeny populációi mindössze néhány helyen maradtak fenn.

## SOUHRN

Ve studii jsou popsány změny populací sysla obecného (*Spermophilus citellus*), k nimž došlo v Komárňansko-Ostřihomské župě v severozápadním Maďarsku v letech 1950 až 2019. Údaje z let před rokem 1990 byly shromážděny od místních informátorů obeznámených se zvířetem a konkrétními místy jeho výskytu (jedná se tak například “občanské vědy”). Průzkum byl prováděn systematicky, na základě jednotné metodiky, která rovněž poskytla příležitost zpětně zkontrolovat data. Srovnání početnosti sysla v různých obdobích bylo založeno na srovnání obsazené plochy. V polovině 20. století lze v dotyčné župě považovat sysla za souvisle rozšířeného jak v nížinách, tak v podhůří a v pahorkatinách, a dokonce i na vhodných místech v horských polohách. Do roku 1990 populační počty sysla drasticky poklesly na přibližně 1,5 % úrovně z 50. let. Dnes je syslí populace v podstatě zhroutená, 99,7 % populačních počtů z poloviny 20. století zmizely. Do současné doby přežily jen malé, izolované a tedy snadno zranitelné populace na několika málo místech.

## A c k n o w l e d g e m e n t s

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